國立中山大學108學年度
碩士暨碩士專班招生考試試題

科目名稱：作業系統【資工系資安碩班碩士班】

—作答注意事項—

考試時間：100分鐘

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國立中山大學108學年度碩士暨碩士專班招生考試試題

科目名稱：作業系統【資工系資安碩班碩士班】　　題號：485001

※本科目依簡章規定「不可以」使用計算機(問答申論題)　　共1頁第1頁

1. **[Process Management: 20%]**
   (1) Explain the five possible states of a process. (5%)
   (2) Explain two common models for inter-process communications. (4%)
   (3) Let us consider five processes arriving in the order of P1, P2, P3, P4, and P5 at time 0:

Process	Burst time	Priority
P1	10	3
P2	1	1
P3	2	3
P4	1	4
P5	5	2

   Show the turnaround time of each process based on the following scheduling algorithms: First-come first-served, round robin (with quantum = 1), shortest job first, and non-preemptive priority (where a smaller priority number indicates a higher priority). (8%)
   (4) What is the many-to-one multithreading model? What are the two drawbacks of this model? (3%)

2. **[Memory Management: 20%]**
   (1) What are the purposes of base and limit registers? (4%)
   (2) Give the six steps to handle a page-fault event. (6%)
   (3) Let average page-fault time and memory-access time be 80μs and 240ns, respectively. What is the expected page-fault rate if we want to get the effective access time smaller than 280ns? Give your calculation. (5%)
   (4) Suppose that it takes 35ns and 105ns to search TLB and access memory, respectively. If TLB has 95% hit ratio, what is the effective memory-access time? Give your calculation. (5%)

3. **[Storage and I/O Management: 20%]**
   (1) What are the two functions supported by a VFS (virtual file system) layer? (4%)
   (2) Consider a disk queue with requests for I/O to blocks on cylinders 103, 188, 42, 120, 7, 138, 76 and 87. Let the disk head currently stay at cylinder 65, and the maximum cylinder be 200. Show the results of SSTF and C-LOOK scheduling methods. (6%)
   (3) Explain seek time, rotational latency, and random-access time for disks. (6%)
   (4) Explain the two major types of memory-mapped I/O. (4%)

4. **[Synchronization and Deadlock: 20%]**
   (1) Explain how the deadlock prevention scheme works. (8%)
   (2) Give three requirements for any solution to the critical-section problem. (6%)
   (3) What is the priority inversion problem? How to solve it? (4%)
   (4) What is conflict serializable for a non-serial schedule? (2%)

5. **[Security: 20%]**
   (1) How to launch an attack of stack and buffer overflow? (6%)
   (2) Explain the two major types of symmetric encryption. (4%)
   (3) Explain how the RSA algorithm works. (5%)
   (4) How does the digital-signature algorithm work? (2%)
   (5) What is an interrupt war caused by tunneling viruses? (3%)

試題請隨卷繳回

國立中山大學108學年度
碩士暨碩士專班招生考試試題

科目名稱：計算機結構【資工系碩士班甲組、乙組】

—作答注意事項—

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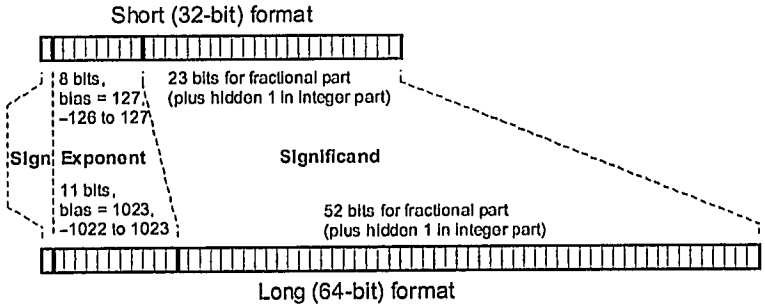
國立中山大學108學年度碩士暨碩士專班招生考試試題

科目名稱：計算機結構【資工系碩士班甲組、乙組】　　題號：434001

※本科目依簡章規定「不可以」使用計算機(問答申論題)　　

1. (20%)

The following figure shows the IEEE 754 standard for floating-point representation of both single-precision (short) and double precision (long) formats to represent a regular floating number $\pm 1.f \times 2^e$ where $1.f$ is called significand and e is the exponent, and other special numbers.



	single-precision (short)	double precision (long)
word width (bits)	32	64
significand bits	23+1 hidden	52+1 hidden
exponent bits	8	11
exponent bias	127	1023
zero	$e + bias = 0, f = 0$	$e + bias = 0, f = 0$
subnormal	$e + bias = 0, f \neq 0$, represent $\pm 0.f \times 2^{-126}$	$e + bias = 0, f \neq 0$, represent $\pm 0.f \times 2^{-1022}$
infinity ($\pm\infty$)	$e + bias = 255, f = 0$	$e + bias = 2047, f = 0$
Not-a-Number (NaN)	$e + bias = 255, f \neq 0$	$e + bias = 2047, f \neq 0$
ordinary number	$e + bias \in [1,254]$	$e + bias \in [1,2046]$

1.1 (2%) What is the binary representation of zero in the single-precision format? Express your answer using binary format similar to *x_xxxxxxxx_xxxxxxxxxxxxxxxxxxxxxxx* where *x* is either 0 or 1.

1.2 (2%) What is the binary representation of the decimal value -0.5 in single precision format?

1.3 (2%) What is the maximum magnitude of ordinary numbers (i.e., excluding infinity, NaN, and subnormal numbers) in single precision floating-point representation? Express your answer in format of $x.xx\cdots xx \times 2^e$ where $x \in \{0,1\}$ and e is the decimal value of the exponent.

1.4 (2%) What is the minimum magnitude of ordinary numbers (i.e., other than zero) in single precision floating-point representation? Express your answer in format of $x.xx\cdots xx \times 2^e$ where $x \in \{0,1\}$ and e is the decimal value of the exponent.

1.5 (2%) What is the minimum magnitude of subnormal numbers in single precision floating-point representation? Express your answer in format of $x.xx\cdots xx \times 2^e$ where $x \in \{0,1\}$ and e is the decimal value of the exponent.

1.6 (2%) What is the representable range of the single-precision floating-point numbers?

1.7 (2%) Is the distance between two neighboring single-precision floating-point numbers the same? Why?

1.8 (2%) For a 32-bit two's complement signed fixed-point representation with 16 integer bits and 16 fractional bits, is the distance between two neighboring numbers the same? Why?

1.9 (2%) Continued with the previous 32-bit signed fixed-point representation, what is the representable range of the 32-bit signed fixed-point format?

1.10 (2%) In general, addition of two 32-bit fixed-point numbers can be finished in one clock cycle. However, addition of two single-precision floating-point numbers usually takes more than one clock cycle. Why? Hint: explain using the operations involved in floating-point addition/subtraction.

2. (20%)

2.1 (5%) A processor is busy with computation 40% of the execution time, and is waiting for I/O access 60% of the execution time. If we replace the processor with a new one which is 10 times faster than the old processor, what is the overall speedup gained using the new processor assuming that the percentage of I/O access remains the same in both processors?

2.2 (5%) If you want to achieve a speedup of 80 for a computation task using 100 processors running concurrently, what fraction of the computation task can be sequential according to Amdahl's law?

2.3 (5%) For an application program running on a multi-processor system with 32 processors, it takes 200 ns to handle reference in a remote memory. Assume that this application program always has hits in the local memory except for remote memory access involving communication. Processors are stalled on a remote request, and the processor clock is 3.3 GHz. Assume that the base CPI (cycles per instruction) is 0.5 and all references hit in cache. How much faster is the multi-processor if there is no communication versus if 0.2% of instructions involve remote communication references? Hint: compute the new CPI first. The speedup is the ratio of the two CPI values.

2.4 (5%) Assume that 25% operations of a computation task are floating-point operations and average CPI (cycles per instruction) for floating-point operations and other operations are 4.0 and 1.33 respectively. Suppose that 2% of the floating-point operations in the task are floating-point division which has CPI = 20. Assume that the two design alternatives are to decrease the CPI of the floating-point division to 2 or the decrease the average CPI of all floating-point operations to 2.5. Compare these two design alternatives using processor performance equation. Which design choice is better? Why? Hint: compute the CPI values of different designs.

3. (20%)

A standard pipelined CPU contains five pipeline stages: instruction fetch (IF), instruction decode (ID), ALU execution (EX), memory access (MA), and result write-back (WB). Assume that the critical path delays of the five types of instruction operations IF, ID, EX, MA, WB are 20ns, 20ns, 50ns, 40ns, 30ns respectively.

3.1 (2%) What is the maximum working frequency of the above CPU?

3.2 (6%) Assume that a computation task contains only 100 instructions and there is no hazard for these instructions, what is the throughput of this task? What is the total latency of finishing executing this task? What is the average cycle per instruction (CPI) in this task?

3.3 (4%) If we want to reduce the pipelined stages from 5 to 4 by merging some of the five types of pipelined operations mentioned above, what is the best design if the speed performance is the first choice? And what is the maximum working frequency of the new design with four pipelined stages?

3.4 (4%) What is data hazard? Give an assembly language example to show one type of data hazard.

3.5 (4%) What is super-pipeline? What are the advantages and disadvantages of super-pipeline design?

4. (20%) Cache

4.1 (2%) How many bits in total (including the tag bits and valid bits) are required for a direct-map cache with 16K bytes of data and 16-byte blocks, assuming a 32-bit address and one valid bit for each cache block?

4.2 (2%) Repeat the above problem for a two-way set-associative cache.

4.3 (2%) Repeat the above problem for a fully associative cache.

4.4 (4%) Compare the advantages and disadvantages of the above three different cache designs. Which one is usually used in the design of TLB (translation lookaside buffer)? Why?

4.5 (2%) The average memory access time (AMAT) per instruction can be expressed as

AMAT = time for a hit + miss rate * miss penalty

Find the AMAT for a processor with a 1ns clock cycle time, a miss penalty of 20 clock cycles, a miss rate of 0.05 misses per instruction, and a cache access time (including hit detection) of 1 clock cycle. Assume that the read and write miss penalties are the same and ignore other write stalls.

4.6 (4%) Assume the miss rate of an instruction cache is 2% and the miss rate of the data cache is 4%. If a processor has a CPI (cycle per instruction) of 2 without any memory stalls and the miss penalty is 100 cycles for all misses, determine how much faster a processor would run with a perfect cache that never missed. Assume the frequency of all loads and stores is 36%.

4.7 (2%) Suppose that in 1000 memory references, there are 40 misses in the first-level cache and 20 misses in the second-level cache. Assume the miss penalty from L2 cache to memory is 200 clock cycles, the hit time of L2 cache is 10 clock cycles, and the hit time of L1 cache is 1 clock cycle. What is the average memory access time? Hint: average memory access time = L1_hit_time + L1_miss_rate * (L2_hit_time + L2_local_miss_rate * L2_miss_penalty) where the L2_local_miss_rate is the number of misses in L2 cache divided by the total number of memory accesses to L2 cache.

4.8 (2%) Continued with the previous problem, and assuming that there is 1.5 memory references per instruction, what are the average stall cycles per instructions? Hint: average memory stall per instruction = L1_misses_per_instruction * L2_hit_time + L2_misses_per_instruction * L2_miss_penalty

5. (20%)

5.1 (5%) What is the advantage of single instruction multiple data (SIMD)? Compare the differences between SIMD in conventional CPU (Central Processing Units) and SIMD in GPU (Graphics Processing Units)

5.2 (5%) What is control hazard? Propose a method to improve the performance degradation due to control hazard.

5.3 (5%) What are the differences of spatial locality and temporal locality during execution of computation tasks in CPU? Give two programming techniques to explain the differences.

5.4 (5%) What is static multiple issue? What is dynamic multiple issue? Compare the differences.

國立中山大學108學年度
碩士暨碩士專班招生考試試題

科目名稱：作業系統與資料結構【資工系碩士班甲組】

—作答注意事項—

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國立中山大學108學年度碩士暨碩士專班招生考試試題

科目名稱：作業系統與資料結構【資工系碩士班甲組】　　題號：434003

※本科目依簡章規定「不可以」使用計算機(問答申論題)　　

1. [Basic Data Structures: 20%]

(1) Given a prefix expression "+ + (18) × (17) (16) × + × (15) (14) (13) (12)", convert it to an infix expression and calculate the result. (4%)

(2) What is simple uniform hashing? Given a hash table with m slots that stores n elements, what is the expected time spent by a failed search if hash collisions are solved by chaining? (4%)

(3) Except that every node is either red or black, how do you make a binary search tree become a red-black tree? (4%)

(4) Given n objects to be sorted, show the average-case running time of the following algorithms: Heap sort, insertion sort, bubble sort, and quick sort. (4%)

(5) Given the adjacency matrix of an undirected graph:

	A	B	C	D	E	F	S
A	0	1	1	0	0	0	0
B	1	0	1	1	0	0	0
C	1	1	0	1	1	1	0
D	0	1	1	0	0	1	0
E	0	0	1	0	0	1	1
F	0	0	1	1	1	0	1
S	0	0	0	0	1	1	0

Show the sequence of nodes that you visit by using breadth-first search and depth-first search. If there are multiple choices to select nodes, just follow the alphabetical order. (4%)

2. [Advanced Data Structures: 20%]

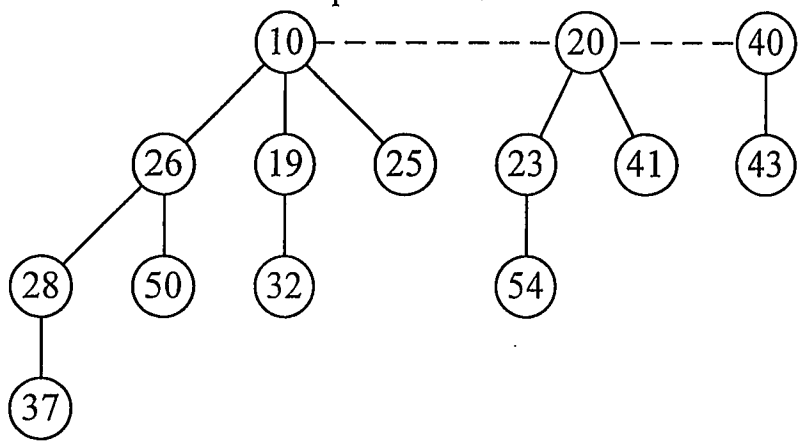
(1) Given a directed graph G = (V, E), what is its strongly connected component? (4%)

(2) Using a B-tree to maintain disk blocks helps reduce the cost of disk access. Why? (4%)

(3) What is the difference between a B^+-tree and a B*-tree? (4%)

(4) What are the two properties of a binomial-heap? (4%)

(5) Consider a Fibonacci heap as follows:



The number in each node gives its key value. Suppose that we decrease key 50 to 18 and then decrease key 37 to 7. Show the result of the revised heap. (4%)

3. [Process and Synchronization: 20%]

(1) What is a race condition? How to solve it? (4%)

(2) What is the difference between deadlock prevention and deadlock avoidance? (4%)

(3) When will you need to use a condition variable? (4%)

(4) What is the difference between asynchronous and deferred cancellation of a target thread? (4%)

(5) What are the four common conditions to cause process termination? (4%)

4. [Memory and I/O: 20%]

(1) Give two benefits of using paging. (4%)
(2) What are the working set and trashing? (4%)
(3) What is the difference between external and internal fragmentation? (4%)
(4) What is the difference between synchronous and asynchronous I/O? (4%)
(5) What are the four common registers for an I/O device? (4%)

5. [Protection and Security: 20%]

(1) What is the principle of least privilege? How does Solaris 10 system implement it? (4%)
(2) What is the difference between a computer virus and a computer worm? (4%)
(3) Give two common solutions to deal with the setuid-on problem in UNIX. (4%)
(4) What are masquerading and replay attack? (4%)
(5) What is the purpose of authentication? What is non-repudiation? (4%)

國立中山大學108學年度
碩士暨碩士專班招生考試試題

科目名稱：工程數學【資工系碩士班乙組】

—作答注意事項—

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國立中山大學108學年度碩士暨碩士專班招生考試試題

科目名稱：工程數學【資工系碩士班乙組】　　題號：434002

※本科目依簡章規定「不可以」使用計算機(選擇題)　　

I. All the following questions are multiple-choice questions.

1. (10%) You can expand the function defined by $f(x)=x^2+3,\ 0<x<3$ in a Fourier series, a cosine series, or a sine series. Please choose the correct answers.
   (A) $f(6)=3$ for Fourier sine series; (B) $f(3)=12$ for Fourier cosine series; (C) $f(0)=3$ for Fourier series; (D) $f(-1)=4$ for Fourier sine series
2. (10%) Please determine which the following matrix is a diagonal matrix.
   (A) $\begin{bmatrix}4&6&-2\\-1&-1&1\\0&0&1\end{bmatrix}$; (B) $\begin{bmatrix}4&6&-2\\-1&-1&1\\0&0&3\end{bmatrix}$; (C) $\begin{bmatrix}2&0&0\\1&2&0\\0&0&-1\end{bmatrix}$; (D) $\begin{bmatrix}-1&-3&-9\\0&5&18\\0&-2&-7\end{bmatrix}$
3. (10%) Please select the right following description
   (A) $A=\begin{bmatrix}2&-3\\1&-1\end{bmatrix}$ and $B=\begin{bmatrix}0&-1\\1&1\end{bmatrix}$ have the same eigenvalues.
   (B) If matrix A is diagonalizable, then the column of A are linearly independent.
   (C) Every orthogonal set of V must be linearly independent.
   (D) If A is an orthogonal matrix, then A is symmetric
4. (10%) Please select the function which is with the largest period
   (A) $f(x)=\cos 5x\cos 3x$; (B) $g(x)=\sin 2x\sin 2x$; (C) $h(x)=\sin 5x\cos 4x$; (D) $q(x)=\cos 2x$
5. (10%)There are six vectors shown below. Please determine the right description
   $\vec{v_1}=\begin{bmatrix}0\\1\\-1\\0\end{bmatrix}, \vec{v_2}=\begin{bmatrix}0\\1\\0\\-1\end{bmatrix}, \vec{v_3}=\begin{bmatrix}1\\0\\0\\-1\end{bmatrix}, \vec{v_4}=\begin{bmatrix}0\\0\\1\\-1\end{bmatrix}, \vec{v_5}=\begin{bmatrix}1\\0\\-1\\0\end{bmatrix}, \vec{v_6}=\begin{bmatrix}1\\-1\\0\\0\end{bmatrix}$
   (A) $\vec{v_1}, \vec{v_5}, \vec{v_6}$ are linear independent
   (B) $\vec{v_1}, \vec{v_3}, \vec{v_4}$ are linear independent
   (C) $\vec{v_4}, \vec{v_5}, \vec{v_6}$ are linear independent
   (D) $\vec{v_1}, \vec{v_2}, \vec{v_3}$ are linear independent

II. All the questions in the following group questions are multiple-choice questions.

You are a nature scientist dedicated to observing a special particle movement phenomenon. Eventually, you find that the observing particle movement track belong to time x can be formulated as $f(x)=\cos 3x$.

6. (10%) Your team leader ask you to analyze the result of the particle movement in the frequency domain. You first decide to apply the Fourier Transform to do this job. Please select the right answer after applying the Fourier Transform.
   (A) $\pi(\delta(\omega-3))$; (B) $\delta(\omega-3)+\delta(\omega+3)$; (C) $\pi(\delta(\omega-3)+\delta(\omega+3))$; (D) $3\pi(\delta(\omega-3)+\delta(\omega+3))$
7. (10%) While receiving the signal, you adopt a circuit to process this signal. After your analysis, you can model the circuit by using the following ordinary differential equation (ODE).
   $$y''(x)+3y'(x)+2y(x)=\frac{1}{2}[\delta(x-3)+\delta(x+3)]$$
   Please use the result in the previous problem and the symmetric property to solve the above ODE and determine the right $y(x)$.
   (A) $\pi(\delta(\omega))$;
   (B) $\pi(\delta(\omega-3)+\delta(\omega+3))\cdot(-e^{-2x}H(x))$;
   (C) $\pi(\delta(\omega+3)-\delta(\omega-3))\cdot(-e^{-2x}H(x)+e^{-2x}H(x))$;

(D) $\pi(\delta(\omega-3)+\delta(\omega-3))\cdot(-e^{-2x}H(x)+e^{-2x}H(x))$

8. (10%) Now, you decide to transfer one signal $s(x)$ (*i.e.*, $s(x)=e^{-2|x|}$)and make the $f(x)$ as the carrier wave. Based on the modulation technique, you can create one new signal $r(x)$ containing the $s(x)$ and $f(x)$. Please describe the formulation of the $r(x)$ in the frequency domain.

(A) $r(x)=\dfrac{2}{4+(\omega-3)^2}$;

(B) $r(x)=\dfrac{2}{4+(\omega+3)^2}$;

(C) $r(x)=\dfrac{2}{4+(\omega-3)^2}-\dfrac{2}{4+(\omega+3)^2}$

(D) $r(x)=\dfrac{2}{4+(\omega-3)^2}+\dfrac{2}{4+(\omega+3)^2}$

9. (10%) After your analysis, you find that it is not practical to analyze the phenomenon in the frequency domain in the continuous time. Afterward, you decide to use Discrete Fourier Transform (DFT) instead. Assume you sample the new created $r(x)$ signal every 2 unit time and collect 4 data from time zero (*i.e.*, x are 0, 2, 4, and 6 sequentially.) If you know that the DFT can be formulated as

$$S[k]=\sum_{n=0}^{L-1}S_n e^{-i(k\cdot\frac{2\pi}{L})n},$$

where the L is the length of the samples and the n indicates the sample number. Please select the right following result of your analysis in the frequency domain after applying your derived DFT.

(A) $S_0=\dfrac{1}{2}$; (B) $S_1=e^{6i-4}+e^{6i+4}$; (C) $S_2=\dfrac{1}{2}(e^{12i-8}+e^{12i+8})$; (D) $S_3=\dfrac{1}{2}(e^{18i-12}+e^{-18i+12})$

10. (10%) To facilitate the DFT analysis, you decide to program a DFT code. Besides, you find that you can adopt a matrix to perform this kind of transform. Please determine the proper Fourier matrix below, which can transform a length-4 data sequence from time domain to frequency domain.

(A) $\begin{bmatrix} 1 & e^{-\omega_0} & e^{-\omega_0} & e^{-3\omega_0} \\ e^{-\omega_0} & 1 & e^{-i\omega_0} & e^{-2i\omega_0} \\ e^{-2\omega_0} & e^{-i\omega_0} & 1 & e^{-3i\omega_0} \\ e^{-3\omega_0} & e^{-2i\omega_0} & e^{-3i\omega_0} & 1 \end{bmatrix}$

(B) $\begin{bmatrix} 0 & e^{-i\omega_0} & e^{-i\omega_0} & e^{-i\omega_0} \\ e^{-2i\omega_0} & 0 & e^{-2i\omega_0} & e^{-2i\omega_0} \\ e^{-3i\omega_0} & e^{-3i\omega_0} & 0 & e^{-3i\omega_0} \\ e^{-4i\omega_0} & e^{-4i\omega_0} & e^{-4i\omega_0} & 0 \end{bmatrix}$

(C) $\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & e^{-i\omega_0} & e^{-2i\omega_0} & e^{-3i\omega_0} \\ 1 & e^{-2i\omega_0} & e^{-4i\omega_0} & e^{-6i\omega_0} \\ 1 & e^{-3i\omega_0} & e^{-6i\omega_0} & e^{-9i\omega_0} \end{bmatrix}$

(D) $\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & e^{-i\omega_0} & e^{-4i\omega_0} & e^{-7i\omega_0} \\ 1 & e^{-2i\omega_0} & e^{-5i\omega_0} & e^{-8i\omega_0} \\ 1 & e^{-3i\omega_0} & e^{-6i\omega_0} & e^{-9i\omega_0} \end{bmatrix}$

國立中山大學108學年度
碩士暨碩士專班招生考試試題

科目名稱：離散數學【資工系碩士班甲組】

—作答注意事項—

考試時間：100分鐘

- **考試開始響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示，**可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，不得另攜帶紙張，請衡酌作答。
- 答案卡請以2B鉛筆劃記，不可使用修正液（帶）塗改，未使用2B鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，其後果由考生自行負擔。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶具有通訊、記憶或收發等功能或其他有礙試場安寧、考試公平之各類器材、物品（如鬧鈴、行動電話、電子字典等）入場。
- **試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。**
- **試題採雙面列印，考生應注意試題頁數確實作答。**
- **違規者依本校招生考試試場規則及違規處理辦法處理。**

國立中山大學108學年度碩士暨碩士專班招生考試試題

科目名稱：離散數學【資工系碩士班甲組】　　題號：434004

※本科目依簡章規定「不可以」使用計算機(問答申論題)　　共1頁第1頁

There are 8 problems in this test. Note that you should write down detailed steps for the solution to each problem; otherwise, no credits for that problem will be given.

1. A committee of 14 is to be selected from 10 men and 10 women. In how many ways can the selection be carried out if
   (a) [7%] there must be seven men and seven women?
   (b) [7%] there must be at least eight men?

2. [10%] Verify that $[(r \leftrightarrow p) \wedge (p \leftrightarrow q) \wedge (q \leftrightarrow r)] \Leftrightarrow [(r \rightarrow p) \wedge (p \rightarrow q) \wedge (q \rightarrow r)]$, for primitive statements p, q, and r.

3. Let A, B be sets from a universe U.
(a) [7%] Write a quantified statement to express the proper subset relation $A \subset B$.
(b) [7%] Negate the result in part (a) to determine when $A \not\subset B$.

4. (a) [7%] Consider an 9×9 chessboard. It contains eighty-one 1×1 squares and one 9×9 square. How many 3×3 squares?
   (b) [7%] Now consider an $n \times n$ chessboard for some fixed $n \in \mathbf{Z}^+$. For $1 \leq k \leq n$, how many $k \times k$ squares are contained in this chessboard?

5. [12%] Let S be a set of five positive integers the maximum of which is at most 9. Prove that the sums of the elements in all the nonempty subsets of S cannot all be distinct.

6. [12%] Given a nonempty language $A \subseteq \sum^*$, prove that if $A^2 = A$, then $\lambda \in A$.

7. (a) [7%] Find the coefficient of x^6 in $(1 + x + x^2 + x^3 + \cdots)^{17}$.
   (b) [7%] Find the coefficient of x^6 in $(1 + x + x^2 + x^3 + \cdots)^n$ for $n \in \mathbf{Z}^+$.

8. [10%] Let $c, d, p, q \in Z$ with $p, q > 0$. Prove that if $c \equiv d \pmod q$ and $p|q$, then $c \equiv d \pmod p$.

試題請隨卷繳回

國立中山大學108學年度
碩士暨碩士專班招生考試試題

科目名稱：離散數學與演算法【資工系資安碩班碩士班】

—作答注意事項—

考試時間：100分鐘

- **考試開始響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，不得另攜帶紙張，請衡酌作答。
- 答案卡請以2B鉛筆劃記，不可使用修正液（帶）塗改，未使用2B鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，其後果由考生自行負擔。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶具有通訊、記憶或收發等功能或其他有礙試場安寧、考試公平之各類器材、物品（如鬧鈴、行動電話、電子字典等）入場。
- **試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。**
- **試題採雙面列印，考生應注意試題頁數確實作答。**
- **違規者依本校招生考試試場規則及違規處理辦法處理。**

國立中山大學108學年度碩士暨碩士專班招生考試試題

科目名稱：離散數學與演算法【資工系資安碩班碩士班】
※本科目依簡章規定「不可以」使用計算機(問答申論題)

題號：485002

There are 9 problems in this test. Note that you should write down detailed steps for the solution to each problem; otherwise, no credits for that problem will be given.

1. A committee of 14 is to be selected from 10 men and 10 women. In how many ways can the selection be carried out if
   (a) [5%] there must be seven men and seven women?
   (b) [5%] there must be at least eight men?

2. [10%] Verify that $[(r \leftrightarrow p) \wedge (p \leftrightarrow q) \wedge (q \leftrightarrow r)] \Leftrightarrow [(r \rightarrow p) \wedge (p \rightarrow q) \wedge (q \rightarrow r)]$, for primitive statements p, q, and r.

3. Let A, B be sets from a universe U.
   (a) [5%] Write a quantified statement to express the proper subset relation $A \subset B$.
   (b) [5%] Negate the result in part (a) to determine when $A \not\subset B$.

4. (a) [5%] Consider an 9×9 chessboard. It contains eighty-one 1×1 squares and one 9×9 square. How many 3×3 squares?
   (b) [5%] Now consider an $n \times n$ chessboard for some fixed $n \in Z^+$. For $1 \leq k \leq n$, how many $k \times k$ squares are contained in this chessboard?

5. [10%] Let S be a set of five positive integers the maximum of which is at most 9. Prove that the sums of the elements in all the nonempty subsets of S cannot all be distinct.

6. (a) [5%] Fermat's Theorem. If p is a prime, prove that $a^p \equiv a(\mathrm{mod}\, p)$ for each $a \in Z$.
   (b) [5%] Euler's Theorem. For each $n \in Z^+, n > 1$, and each $a \in Z$, prove that if $\gcd(a,n) = 1$, then $a^{\phi(n)} \equiv 1(\mathrm{mod}\, n)$.

7. (Algorithm points) In each of the following, $f : Z^+ \rightarrow R$. Solve for $f(n)$ relative to the given set S, and determine the appropriate \big-Oh" form for f on S.
   (a) [5%] $f(1) = 5, f(n) = 6f\left(\frac{n}{3}\right) + 6, n = 3, 9, 27, \ldots, S = \{3^i | i \in N\}$.
   (b) [5%] $f(1) = 7, f(n) = f\left(\frac{n}{6}\right) + 8, n = 5, 25, 125, \ldots, S = \{5^i | i \in N\}$.

8. (Algorithm points) For each of the following pairs $a, b \in Z^+$, determine $\gcd(a, b)$ (by Euclidean Algorithm) and express it as a linear combination of a, b.
   (a) [6%] 251, 1920

(b) [6%]1371, 2587

(c) [6%] 1689, 6001

9. (Algorithm points) (a) [6%] Apply Dijkstra's algorithm to the graph shown in the following Fig. 1 and determine the shortest distance from vertex *b* to each of the other vertices in the graph.

(b) [6%] Find a shortest path from vertex *g* to each of the vertices *a*, *b*, and *c*.

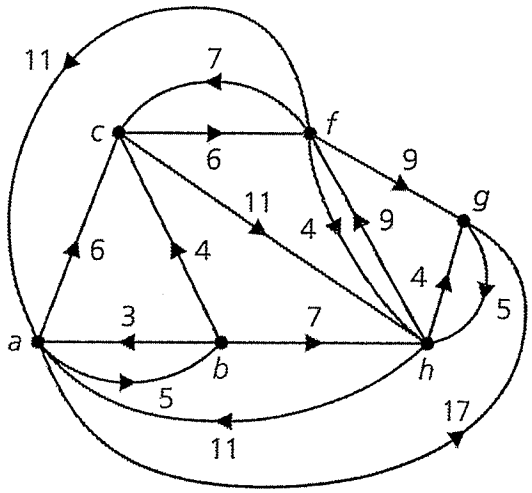

Fig. 1